

TWO NEW SPECIES OF *BRANCHINELLA* (ANOSTRACA: THAMNOCEPHALIDAE)  
AND A REAPPRAISAL OF THE *B. NICHOLLSI* GROUP

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*Branchinella clandestina* sp. nov. is described from the Queensland Paroo and *B. mcraci* sp. nov. from the Pilbara in Western Australia. Both have a simple frontal appendage consisting of a trunk and two branches, but differ from each other and other similar species such as *B. affinis* Linder, *B. longirostris* Wolf and *B. latzi* Geddes by many features. These two species increase the number of described Australian *Branchinella* to 31 species. The raising of *B. nichollsi hattahensis* Geddes and *B. nichollsi buchananensis* Geddes, both present in the Paroo catchment, to species status is confirmed with lectotypes designated and species descriptions provided. Similarities and differences between *B. nichollsi*, *B. hattahensis* and *B. buchananensis* are discussed. □ *Branchinella*, *Anostraca*, *Thamnocephalidae*, *new species*.

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Until a few years ago, Australia had 18 described species of *Branchinella*. Belk & Brtek (1995) elevated, with no discussion or justification, the 2 subspecies of *B. nichollsi* Linder to species rank (thus *B. buchananensis* Geddes 1981 and *B. hattahensis* Geddes 1981) to swell the Australian list to 20 species. Timms (2001, 2002) and Timms & Geddes (2003) added 9 species, mainly from remote areas. Collecting from such areas has yielded 2 further species, described here.

The unceritical elevation of *B. n. buchananensis*, and *B. n. hattahensis* to species status has not been questioned, or supported, on anatomical grounds, but Remigio et al. (2003), using DNA, concluded that *B. buchananensis* and *B. hattahensis* were related at the subspecific level (no material of *nichollsi* was available). No formal decision was made.

SYSTEMATICS

Class CRUSTACEA Brünnich, 1772  
Order ANOSTRACA, Sars, 1867  
Family THAMNOCEPHALIDAE Packard,  
1883  
*Branchinella* Sayce, 1902

*Branchinella clandestina* sp. nov.  
(Figs 1,2)

ETYMOLOGY. The name arises from this fact that this species lives in a pool that was seen regularly for many years of a long-term study of the Paroo but not sampled until the 13th year. In other words it probably lived many times when the pool was full, right under the collector's gaze, yet went unnoticed — a clandestine existence.

MATERIAL. HOLOTYPE: ♂ Queensland Museum (hereafter QM) W26951. ALLOTYPE: ♀ QMW27006. PARATYPES: QMW27007 five ♂♂. All collected from the type locality by the B.V. Timms, 5 December, 2001. OTHER MATERIAL. Four ♂♂ raised in December 2002 from dried mud from the type locality, QMW27008.

TYPE LOCALITY. Unnamed flood plain pool near Caiwaro Crossing of the Paroo River, Currawinya National Park, 28°41'55"S, 144°46'40"E, SW Queensland. Collected under permit WITK00786602 issued by the Queensland Parks and Wildlife Service.

DESCRIPTION. *Male*. Length of mature males 10-11.2mm; holotype 10.8mm.

First antennae slightly longer than proximal segment of second antenna (Fig. 1A); apex bevelled and bearing subapically 2 short setae and 2-3 recurved hair-like setae. Second antennal basal segments fused medially for about one-third of their length proximally. These segments with a raised field of minute denticles along much of their length medially. Distal segment of second antenna slightly longer than length of the proximal segment, flattened, blade-like, curved with apices directed anteriolaterally (Fig. 1A). In life (Fig. 1B) the second antennae presents with the proximal segment vertical at right angles to the body axis, and the distal segments curved in three planes, so that the concave medial surface faces anteriorly and the convex lateral surface is aligned ventromedially. Curvatures on the medial and lateral margins of the distal segment different so that segment is widest in the central part. Apical

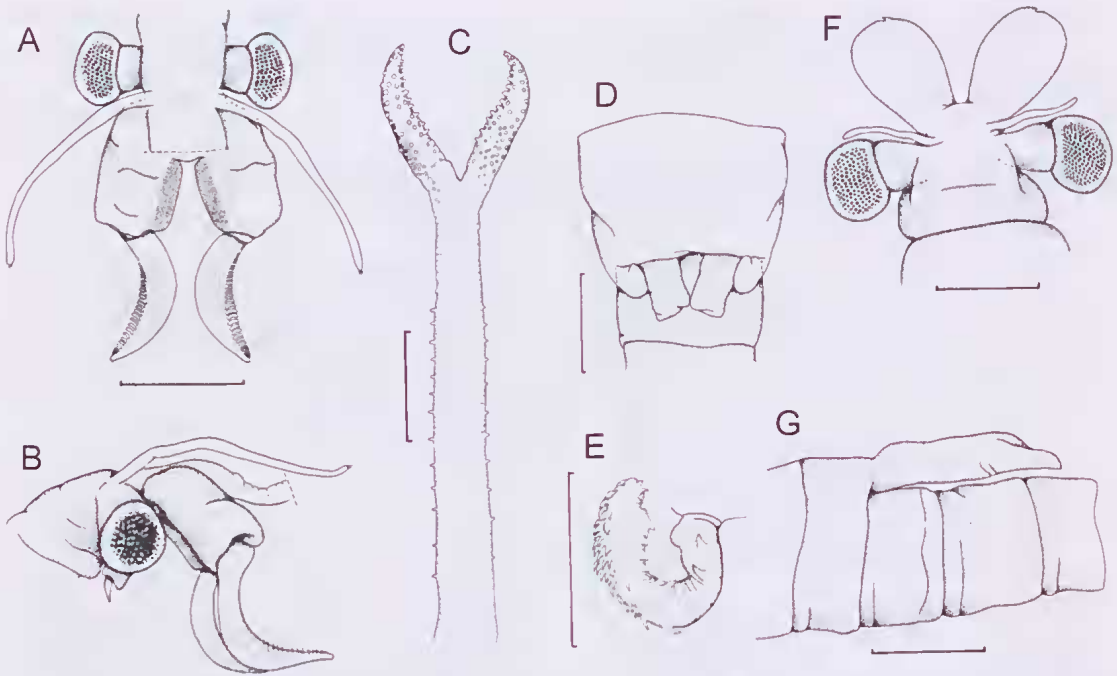


FIG. 1. *Branchnella clandestina* sp. nov. A, lateral view of head of  $\delta$ ; B, dorsal view of  $\delta$  second antenna; C, dorsal view of frontal appendage of  $\delta$ ; D, rigid portion of base of penes; E, penis; F, dorsal view of head of  $\eta$ ; G, lateral view of brood pouch. Scale bars = 1mm.

two-thirds of distal segment with transverse ridges on the concave medial margin which appears anteriolaterally placed when viewed dorsally (Fig 1A).

Frontal appendage (Fig. 1C) about half body length and consisting of a long narrow trunk and two simple branches about a fifth of the length of the trunk. Trunk weakly pseudosegmented with small, simple, blunt papillae spaced along each lateral margin. Branches distal two thirds bearing dense papillae on both margins of the branches and continuing on the ventral surface in rows of 3-5 papillae.

Rigid basal portion of penes (Fig. 1D) cylindrical and protruding beyond the genital segments onto the first abdominal segment. Each attended laterally by a small rounded protrusion, smaller than the bases of the penes. Eversible portion of penes (Fig. 1E) about twice as long as rigid base and margined with a row of triangular denticles laterally and similar denticles apically on medial side, but soon becoming spike-like and crowded on the distal two-thirds of the penis.

Fifth thoraeopod (Fig. 2A) with endites 1+2 (fused) and 3 broad and with evenly curved margins bearing numerous setae; endite 1+2

about 4 times the size of endite 3. Each endite with a one-sided pectinate anterior setae, the second setae about half as long again as the first setae. Both attended by a small spine proximally. Endites 4-6 small asymmetrical protrusions covered in small spines. Endites 4, 5 and 6 with 2, 2, and 1 anterior setae respectively, the distal member of each pair distinctly longer than the proximal member. These anterior setae plumose. Endites 4, 5 and 6 with 3, 2 and 2 posterior setae respectively. Endopodite broadly rounded, almost quadrangular bearing many plumose setae, long on the lateral margin decreasing to short on the medial margin. Bases of these setae unadorned. Exopodite twice as long as endopodite, suboval and bearing numerous plumose setae. Epipodite suboval, widest proximally and longer than the endopodite; margin unadorned. Praeepipodite twice as long as broad; margin with a series of small asymmetrical spines.

Telson with ecreopods subequal in length to the three posterior-most abdominal segments and bearing plumose setae on both margins. Setae longest midway along each cercopod.

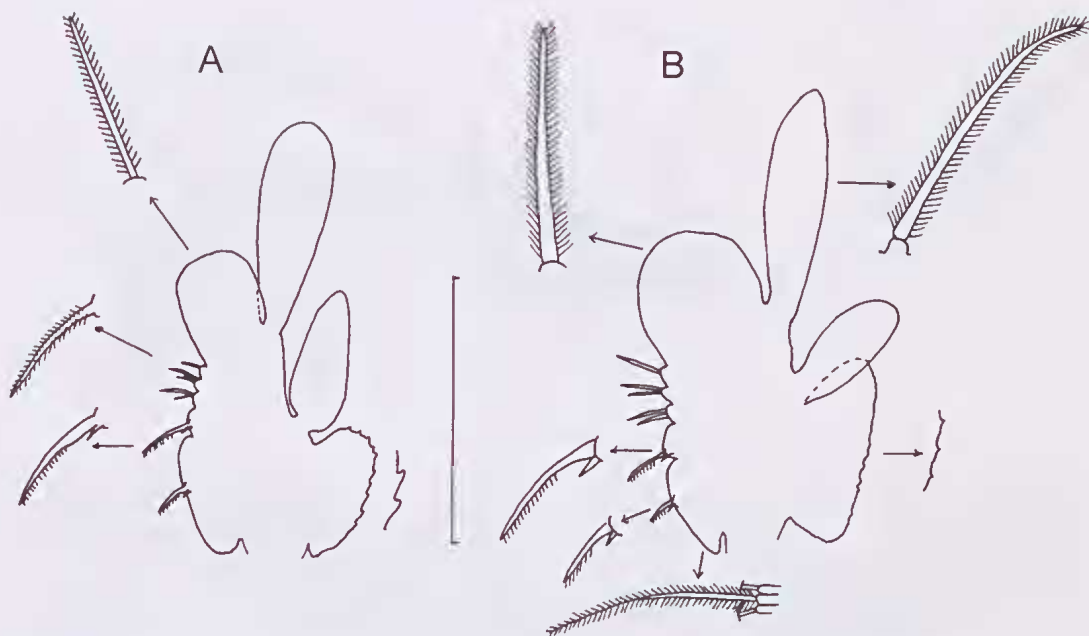


FIG. 2. Fifth thoracopods: A, *Branchinella clandestina* sp. nov.; B, *Branchinella mcraei* sp. nov. Scale bar = 1mm.

*Female*. Length of allotype 12.2mm. No other female lengths available. First antennae (Fig. 1F) slightly shorter than the eye plus eye stalk, and also shorter than the second antennae. First antenna setae as in male. Second antennae subcylindrical, tapering proximally and slightly longer than eye stalk plus eye; apex rounded and bearing a sharp projection flanked laterally by a small longitudinal notch. No setae on distal margin. Brood pouch (Fig. 1G) extending over three abdominal segments, distal part cylindrical. Thoracopods and cercopods similar to those of male.

**DIAGNOSIS.** Male with frontal appendage of a trunk and 2 simple branches. Each branch about 1/5 length of the trunk. Distal segment of second antenna curved medially and anteriorly and twisted so that lateral surface and medial surfaces appear opposite to their usual position.

**REMARKS.** This species is most similar to *B. affinis*, *B. latzi*, *B. longirostris* and the other new species described here, *B. mcraei*. All share a broadly similar frontal appendage; i.e. an appendage consisting of a trunk and two simple branches and with sensory papillae. Of this group, *B. longirostris* readily separates as it has spines at the base of the branches and a lateral protuberance proximal to these spines (Timms,

2004, fig. 70). The relative length of the trunk and branches separate *B. clandestina* from *B. affinis* and *B. mcraei* — in *B. clandestina* the branches are about one fifth of the total length of the frontal appendage (Fig. 1C), whereas in *B. affinis* they are about half (see Timms, 2004, fig. 69) and in *B. mcraei* and *B. latzi* about one quarter to one third (Fig. 4B and *ibid.*, fig. 71). *B. clandestina* has the distal segment of the second antenna curved in three planes, so that it is curved medially and anteriorly (Fig. 1B), whereas in the other four species this segment is curved only medially (Figs 3, 4A and *ibid.*, figs 69, 70, 71). Furthermore there is a difference in the number of sensory papillae in the four species — in *B. latzi* both trunk and branches are covered in papillae (*ibid.*, fig. 71), compared to papillae only on the distal half of the frontal appendage (i.e. the branches plus some of the trunk) in *B. mcraei* (Fig. 4B), only on the distal two thirds of the branches in *B. clandestina* (Fig. 1C) and not at all in *B. affinis* (*ibid.*, fig. 69).

Other less diagnostic differences between the 5 species concern the basal segment of the second antenna and the base of the penes. Considering the second antenna, only the two new species have a pad of papillae medially on the unfused distal part of the basal segment. *B. affinis* usually has a small area of papillae medioapically on the



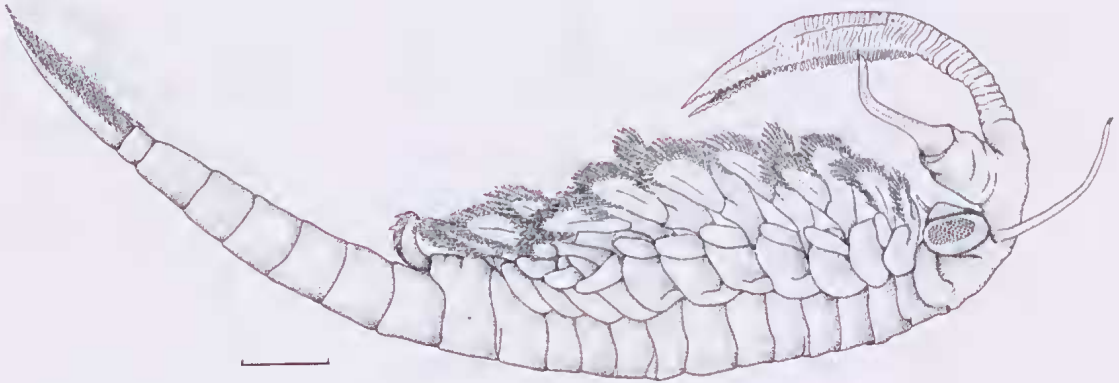


FIG. 3. Lateral view of ♂ *Branchinella mcraei* sp. nov. Scale bar = 1mm.

basal segment, while *B. longirostris* and *B. latzi* lack such papillae. Four of the five species have lateral processes on the base of the penes, the exception being *B. latzi*. Not surprisingly for *Branchinella* (Geddes, 1981; Timms, 2004) the females cannot be distinguished apart, except for *B. clandestina* and *B. longirostris* which have bulbous second antenna. These two can be separated by the prominent apical point being centrally placed in *B. longirostris*, while *B. clandestina* has a small apical point medially displaced and a notch lateral to this (cf. fig. 89 in Timms, 2004 with Fig. 1F).

***Branchinella mcraei* sp. nov.**  
(Figs 2-4)

ETYMOLOGY. For Jane McRae, Western Australian Dept of Conservation and Land Management, Wanneroo, who collected the specimens and previously two other new fairy shrimp from Western Australia (Timms, 2002).

MATERIAL. HOLOTYPE: ♂ West Australian Museum (hereafter WAM) C34035. ALLOTYPE: ♀ WAM C34036. PARATYPES: WAMC34037 five ♂♂ and 5 ♀♀. OTHER MATERIAL. 13 ♂♂ and 20 ♀♀ from type locality, WAMC34038. All collected by A. Pinder & J. McRae, 27 August, 2003.

TYPE LOCALITY. Myanore Creek Pool, Pilbara, WA, 21°29.6'S, 115°46.5'E. This is site PSW014 of CALM's Pilbara study (S. Halse, pers. comm.). At the time of collection pH was 7.3, TDS 33mg/L and the pool was a very turbid reddish brown.

DESCRIPTION. *Male*. Length of adults (Fig. 3) 8.5-9.4mm; holotype 8.8mm.

First antennae approximately 3/4 length of second antenna (Fig. 4A); apex bevelled and bearing subapically three subequal short setae and typically 2 minute, recurved hair-like setae. Proximal segment of second antennae (Fig. 4A)

fused basally and remainder set laterally at about 45°. Second antenna proximal segment with a longitudinal blade-like medial ridge armed with denticles; the 2 ridges separated by a central, transverse, recessed unadorned area of the clypeus somewhat shorter in length of the ridges. Distal segment of second antenna with an expanded base, remaining portion evenly thin, circular in cross section and curved medially in the middle part. An elongated patch of minute denticles on dorsal middle section and extending proximally onto expanded base; distal half with slight transverse ridges medially; apex hyaline and pointed. Distal segment slightly longer than proximal segment and generally held at right angles to the body axis.

Frontal appendage (Fig. 4B) about half body length and consisting of a wide trunk and two branches about a third of the trunk length. Each branch like an elongated triangle with a long tapering apex. Proximal half of trunk strongly pseudosegmented and unadorned. Remainder of trunk and lateral edge of branches with numerous short digitiform spineless papillae. Smaller similar papillae on the shanks of digitiform papillae and also on ventrally in rows onto the pseudosegments of the trunk and branches carrying each digitiform lateral papillae. Each row with 3-4 papillae on proximal part of trunk, increasing to 5-6 at the trunk-branch boundary, decreasing to 2-3 at the branch apex. Medial edge of each branch, ventral surface of proximal trunk, central ventral surface of distal trunk, and whole of dorsal surface of trunk and branches unadorned.

Rigid basal portion of penes (Fig. 4C) almost confined to genital segments; penes bases cylindrical and protruding a little onto first

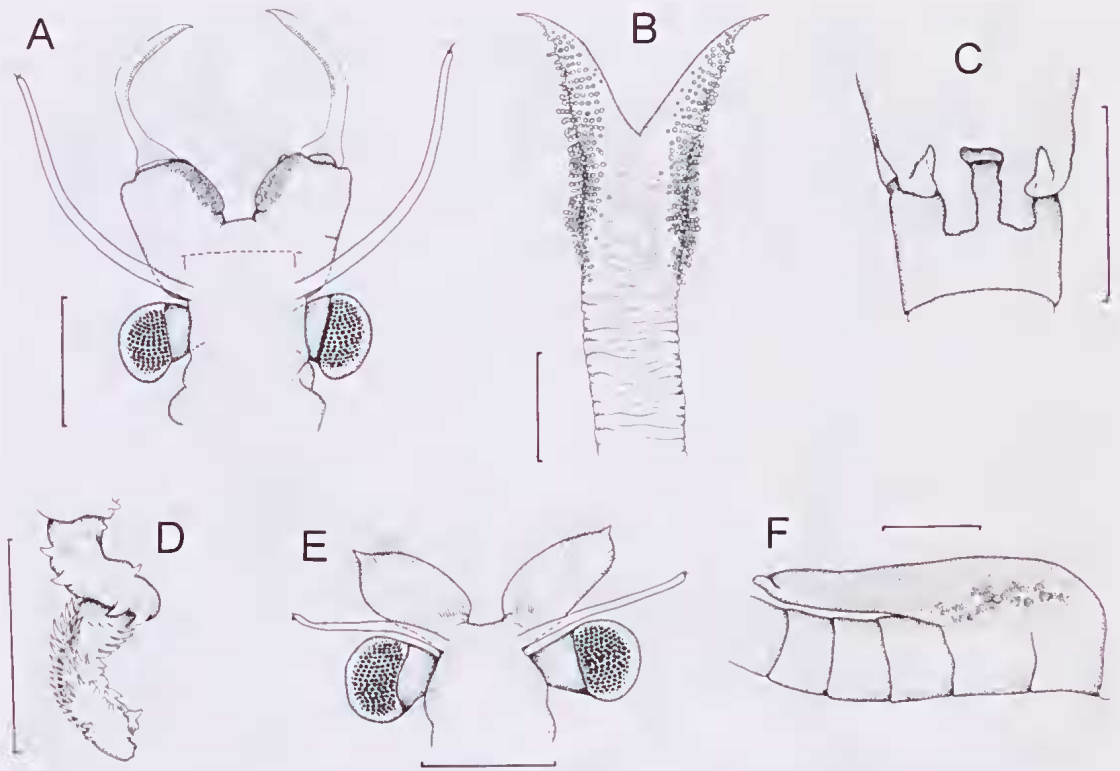


FIG. 4. *Branchinella mcraei* sp. nov. A, dorsal view of ♂ head; B, dorsal view of frontal appendage of ♂; C, rigid portion of base of penes; D, penis; E, dorsal view of head of ♀; F, lateral view of brood pouch. Scale bars = 1 mm.

abdominal segment and each attended laterally by a flaccid triangular projection subequal in length to the rigid basal portion of penes. Eversible portion of penis (Fig. 4D) approximately twice as long as basal portion of penes; laterally with a single row of broadly based triangular spines and medially with a few similar spines apically, but most the medial surface covered sharp and narrow spines. Sometimes, even in the same animal, penal spines greatly reduced to a few well-spaced small spines on each surface.

Fifth thoracopod (Fig. 2B) with endites 1+2 (fused) and 3 broad with evenly curved margins bearing numerous posterior setae; endite 1+2 about 3 times the size of endite 3. Each endite with anterior seta with a pecten on one side, the second anterior seta almost twice as long as the first. Both attended by a small spine proximally. Endites 4-6 small asymmetrical protrusions covered with small spines. Endites 4, 5 and 6 with two, two and one plumose anterior setae respectively, the distal of each pair slightly longer than the proximal setae. Endites 4, 5 and 6 with three, two and two posterior setae respectively.

Endopodite broadly rounded and bearing many plumose setae, long on the lateral margin decreasing to short on medial margin. Bases of these setae unadorned. Exopodite narrowly suboval and bearing numerous long setae. Epipodite suboval and unadorned and shorter than endopodite. Praeepipodite 2-3 times as long as broad and margin typically smooth, but maybe weakly serrated with minute spines on proximal lateral edge in some specimens.

Telson with cercopods approximately as long as 2.5 posteriormost abdominal segments and bearing plumose setae of both margins. Setae longest midway along each cercopod.

*Female.* Length of adults 9.2-10.0mm; allotype 9.5mm. First antennae (Fig. 4E) with setae as in male; subequal in length to second antennae. Second antenna leaf-like, about 3 times longer than wide and terminating in a symmetrically placed narrow sharp projection. Numerous small hair-like setae on the distal margin. Brood pouch (Fig. 4F) extending back over almost 6 segments, 2 genital and 3-4 abdominal; distal part

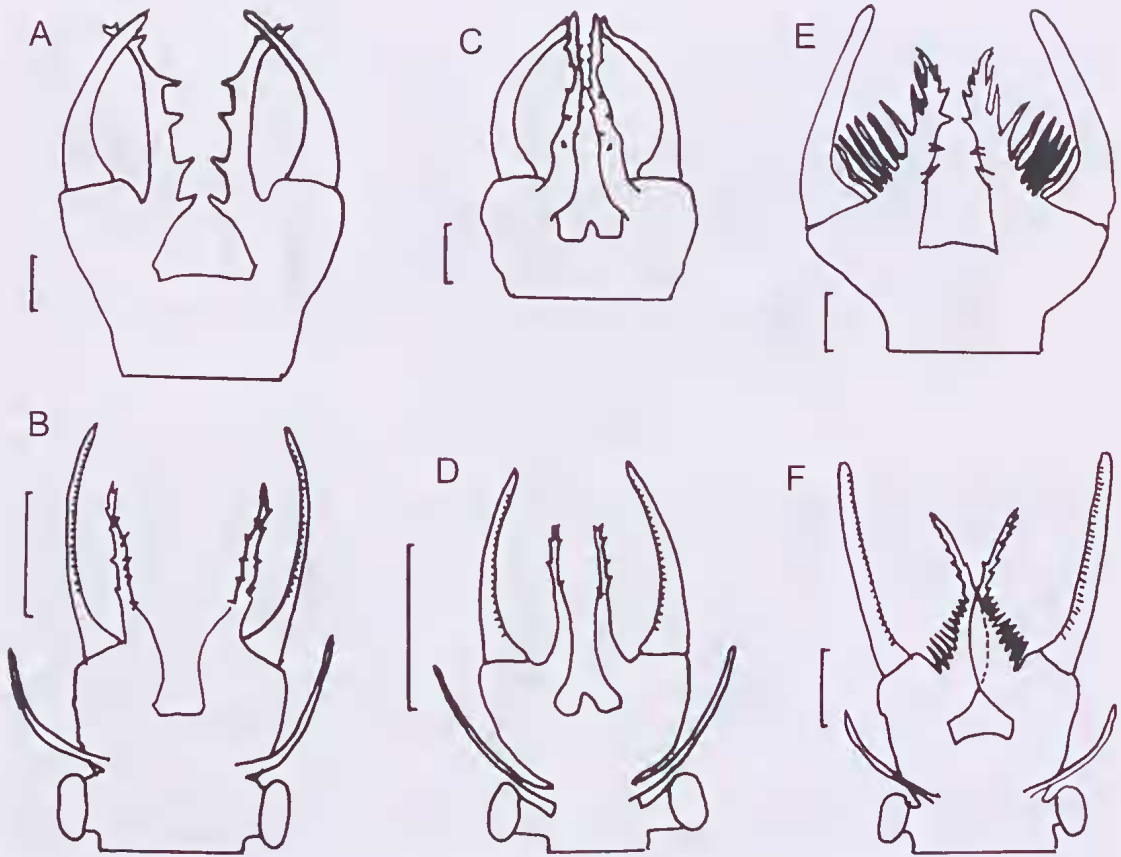


FIG. 5. Dorsal views of ♂ heads or second antennae of members of the *Branchinella nichollsi* Linder complex: A, *B. nichollsi* from Geddes, 1981, fig. 5a; B, *B. nichollsi* from Timms, 2004, fig. 54a and based on material from Lake Arrow, WA; C, *B. hattahensis* Geddes from Geddes, 1981, fig. 5b; D, *B. hattahensis* Geddes from Timms, 2004, fig. 55a; E, *B. buchananensis* Geddes from Geddes, 1981, fig. 5c; F, *B. buchananensis* Geddes from Timms, 2004, fig. 53a and based on Lake Gidgee material. Scale bars = 1mm.

cylindrical. Thoracopods and cercopods similar to those of male.

**DIAGNOSIS.** Male with frontal appendage in the form of a trunk and 2 simple branches. Branches about 1/3 length of trunk and with a narrow appendage apically. Flaccid triangular projection lateral to base of penes and subequal in length.

**REMARKS.** This species is most similar to *B. affinis*, *B. latzi*, *B. longirostris* and *B. clandestina*, due mainly to broadly similar frontal appendages. Differences between the 5 species have been discussed in the remarks for *B. clandestina*, but further comments are needed here on the distinction between *B. mcraei* and *B. latzi*, the species most similar to *B. mcraei*. The two are most easily separated by the structure of the branches of the frontal appendage. In *B. latzi*

the branches are oval with a narrow appendage apically (Timms, 2004, fig. 71) compared with the triangular branches that narrow evenly apically in *B. mcraei* (Fig. 4B). A further distinction between these two species is the lateral projections to the bases of the penes in *B. mcraei* and their absence in *B. latzi*.

#### THE BRANCHINELLA NICHOLLSI GROUP

*Branchinella nichollsi* Linder 1941 consists of 3 taxa, *B. nichollsi nichollsi*, *B. nichollsi hattahensis* and *B. nichollsi buchananensis*, originally described as subspecies by Geddes (1981) but elevated to species unceritically by Belk & Brtek (1995). A re-examination of the material available of *B. nichollsi hattahensis* and *B. nichollsi buchananensis* to Geddes and of new collections of all three taxa follows.



**Branchinella nichollsi** Linder, 1941  
(Fig. 5A,B)

*Branchinella nichollsi* Linder, 1941: 249, fig 33.

*Branchinella nichollsi nichollsi* Geddes, 1981: 264, fig. 5a.

NEW MATERIAL. WAM C34039 from Lake Arrow, via Kalgoorlie, WA, 30°32'S, 121°24'E, 14 May 1995, coll. A Chapman.

REMARKS. Both Linder (1941) and Geddes (1981) provided an adequate description of *B. nichollsi*. In brief, its distinctive features concern the lack of a frontal appendage and an antennal appendage apomedially on the basal segment of the second antenna. Geddes (1981) showed this antennal appendage as about the same length as the distal segment and with about 5 short branches subequally spaced medially (Fig. 5A). However, the new material has this appendage only about 2/3 length of the second segment and with about 10 unorientated papillae (Fig. 5B). The penes have ligulate lobes lateral to their bases (Linder, 1941; Geddes, 1981); in the new material these lobes are curved laterally and slightly longer than the base of the penes (Timms, 2004, fig. 54b). This is a minor difference and is considered intraspecific variation. The thoracopods are also distinctive (Linder, 1941; Geddes, 1981, fig. 5c) with the large endopodite (significantly larger than the exopodite in all thoracopods except the first) and the posterior setae numbering 6-7:5-7:5 on endites 4, 5, and 6 respectively, instead of 3:2:2 as in most other Australian species of *Branchinella*.

DIAGNOSIS. Male lacks a frontal appendage, but has an apomedial outgrowth from basal segment of second antenna. Outgrowth tubular with short or long papillae along whole length. Clypeus without a blunt triangular outgrowth medially. Base stem of penis without a transverse protrusion laterally.

**Branchinella buchananensis** Geddes, 1981  
(Figs 5E,F, 6, 7)

*Branchinella nichollsi buchananensis* Geddes, 1981:264, fig 5c.

*Branchinella buchananensis* Geddes; Belk & Brtek, 1995: 323-324.

ETYMOLOGY. From Lake Buchanan.

MATERIAL. LECTOTYPE: ♂ QMW26939. PARALECTOTYPES: two ♂♂, QM26940, 12 ♀♀, QM26941; All collected by T.S. House, 10 July, 1971. OTHER MATERIAL. QMW26942, QMW216943, Hatch Lake, Wombah Station, via Hungerford, 28°56'S, 144°57'E, QMW26944, QMW26945, Gidgee Lake, NSW, 29°33'S, 144°50'E.

TYPE LOCALITY. Lake Buchanan, NE Qld, 21°36'S, 145°52'E.

DESCRIPTION. *Male*. Length of adults 19.2-31mm; lectotype 23mm. First antennae 80% the length of the proximal segment of the second antenna (Fig. 6A); apex bevelled and bearing a subapical tuft of 3 short subequal setae. Second antennae (Fig. 6A) fused at base with much of the basal segment cylindrical. Distal segment of second antennae with a swollen asymmetrical base with remaining portion evenly thin, rounded in cross section and bent slightly medially just beyond the base. Distal segment a little longer than proximal segment. Dorsal surface of distal segment covered with small polygons, which are elongated a little towards the apex; ventral surface with small raised transverse ridges.

Frontal appendage absent. Antennal appendage present on the medial surface of proximal segment of second antenna (Fig. 6A). Antennal appendage lamellar at base narrowing apically and about two-thirds the length of distal segment of second antenna. Antennal appendage bears numerous long papillae on lateral surface, gradually becoming shorter towards the apex and eventually replaced by short papillae apically which also extend halfway down the distomedial margin. Proximal 10 (or so) of the long papillae terminating in spiny anvil-like expansions, with remainder and the short papillae terminating in a sharp point, each with a few short lateral spines.

Rigid basal portion of penes (Fig. 6B) cylindrical and protruding onto about 1/3 of the first abdominal segment. Each penis base attended laterally by a conical soft outgrowth protruding beyond the bases of the penes and separated from them basally by a hemispherical cavity rimmed laterodorsally by the outgrowth. Penis not extended on lectotype or paralectotypes, but one is available in the Gidgee Lake material (Fig. 6C). Everted penis about 2mm long (whole animal length 29mm) and almost the length of first two abdominal segments. A narrow row of broadly based asymmetrical spines on lateral surface and a broad row of similar spines on medial surface near apex, but subapically changing to numerous narrow spines. All spines point basally.

Fifth thoracopod (Fig. 7) with endites 1+2 (fused) and 3 broad with evenly curved margins bearing numerous posterior setae (ca 40 and 10 respectively); endite 1+2 almost 3 times the size of endite 3. Endite 1 +2 with two anterior setae,

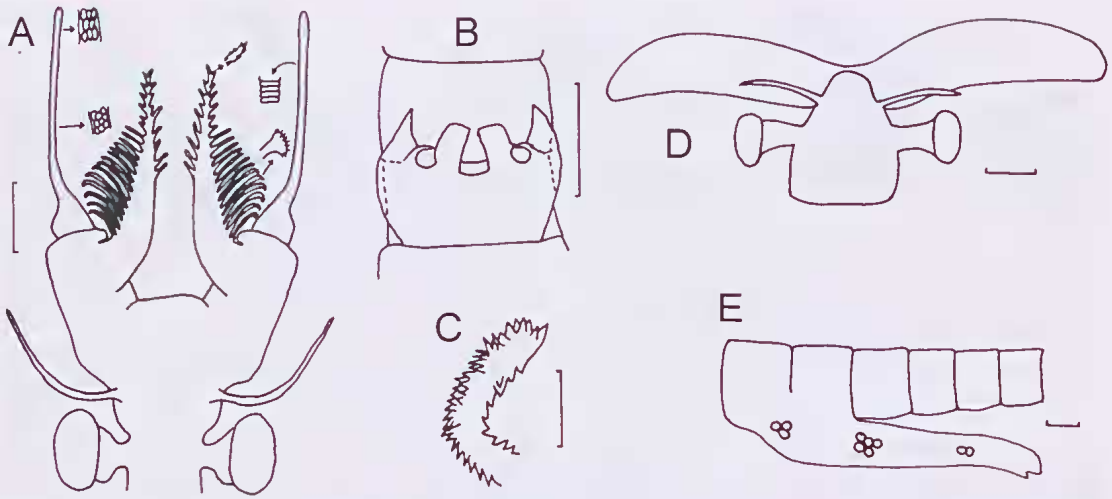


FIG. 6. *Branchinella buehanensis* Geddes. A, dorsal view of head of ♂ holotype; B, ventral view ♂ genital segments; C, lateral view of ♂ penis from Lake Gidgee; D, dorsal view of head of ♀ allotype; E, lateral view of brood pouch of ♀ allotype. Scale bars = 1mm.

the basal one smooth and with no subtending spine, the distal one with a double row of pectinate setae on one side and a small subtending spine. Anterior setae of endite 3 almost twice the length of the anterior setae of endite 1+2 and with a double row of pectinate setae on one side. Endites 4-6 asymmetrical protrusions about the size of the 3rd endite and covered with small spines. Endites 4, 5 and 6 with two, two and one anterior setae respectively, and six, five and five posterior setae respectively. Proximal anterior setae of endites 4 and 5 smooth and twice as long as distal anterior setae; later with a double row of pectinate setae. Endopodite large, twice as long as exopodite and broadly triangular with a blunt apex. Setae (about 14) on medial surface smooth, but with a few short spines crowning pedestal-like bases and with a cluster of very small spines near and beyond a small pit about a third way along their length. Setae on medial surface of endopodite and the posterior setae of the endites glabrous. Setae on lateral surface plumose and with 0-8 spines crowning their pedestals. These setae decrease in length basally and in number of crowning spines on the pedestals (6-8 near apex, 3-5 midway, and 0-1 basally). Exopodite subquadrate but with a rounded apolateral corner. Its setae numerous (>50), thinner and longer than exopodite setae, but still plumose and with pedestals crowned with little spines (3-6). Epipodite oval three times longer than wide and unadorned. Praecipodite

twice as long as broad and with minor enulations on lateral margin.

Telson with cereopods about as long as last two abdominal segments. Cereopods bear plumose setae of both margins; these setae almost subequal along each cereopod, but definitely shorter proximally and apically.

*Female.* Length of adults 20-33mm, paralectotype 28mm. First antennae (Fig. 6D) filiform and about one third the length of second antenna. Second antenna lamellar with a rounded asymmetrical apex and reaching back to 2nd or 3rd thoracic segments. Brood pouch (Fig. 6E) extending over genital segments and almost four abdominal segments; distal part cylindrical. Thoracopods and cereopods similar to those of male.

**DIAGNOSIS.** Male lacks a frontal appendage, but has an apomedial antennal appendage from basal segment of second antenna. Proximally this appendage is lamellar with numerous long lateral papillae. Base of penis without a transverse protrusion laterally.

**REMARKS.** Material from Gidgee Lake differs slightly from the type material from Lake Buchanan and also from the Hatch Lake sample. The antennal appendage has fewer long papillae than in the Lake Buchanan specimens, with only 7-8 anvil-tip papillae and 4 of the spear-pointed papillae in the September 1998 sample. The May 2000 sample differs further in that these long



papillae are without specially modified apices and are also fewer in number (Fig. 5F). Also the surface of the clasps is unadorned. Given that these Gidgee specimens (mean length 18.7mm) are smaller than Buchanan specimens (mean length 24.8mm) and the September 1998 Gidgee males (mean length 28mm), they may be undeveloped (meaning that the apices differentiate later in development, and that adornment of the distal segment of the second antenna are also a late-developing feature). On the other hand, all Gidgee specimens had a reduced number of long papillae on the apomedial outgrowth of the second antenna, so this character is not fixed in this species.

***Branchinella hattahensis* Geddes, 1981**  
(Figs 5C,D, 8)

*Branchinella nichollsi hattahensis* Geddes, 1981: 264, fig 5b.

*Branchinella hattahensis* Geddes; Belk & Brtek, 1995: 324.

ETYMOLOGY. From Hattah Lake.

MATERIAL. LECTOTYPE: ♂, QMW26946, November 1971, coll. G. Arthur; PARALECTOTYPES: four ♂♂, one ♀, QMW26947 November 1971, coll. G. Arthur. OTHER MATERIAL: QM W26948, Lake Numalla, 28°42'S, 144°19'E, QM W26949, Mid Kaponyee Lake, Currawinya National Park, SW Qld, 28°50'S, 144°19'E, QM W26950, South Kaponyee Lake, Currawinya National Park.

TYPE LOCALITY. Hattah Lake, 34°44'S, 142°21'E, NW Victoria.

DESCRIPTION. *Male*. Length of adults 18-44mm; lectotype 44mm. First antennae subequal in length to proximal segment of the second antenna (Fig. 8A); apex bevelled and bearing subapically a tuft of 2-3 subequal short setae. Second antennae proximal segments (Fig. 8A) fused at base with approximately half of distal portion free, cylindrical and aligned with body axis. Clypeus with a blunt triangular outgrowth ventromedially. Distal segment of second antennae with a swollen asymmetrical base with long, thin remaining portion, rounded in cross section, slightly curved medially but near apex curvative reversed so that apex curved laterally. Distal segment about 1.5 times longer than proximal segment. Dorsal surface of distal segment granulated, ventral surface with small raised transverse ridges.

Frontal appendage absent. Antennal appendage present on medial surface of proximal segment of second antenna (Fig. 8A). Antennal appendage tubular, narrowing only a little along its length

and almost as long as the distal segment of antenna; numerous short papillae on apical half.

Rigid basal portion of penes (Fig. 8B) cylindrical and protruding onto approximately a third of the first abdominal segment. Mid length each penis base with a short transverse protrusion laterally and attended laterally by a pointed soft outgrowth about same length as bases of penes and separated from them basally by a hemispherical cavity. Everted penis about 3mm long and almost the length of two abdominal segments. A narrow row of broadly based asymmetrical spines on lateral surface and a broad row of similar spines on medial surface near apex, but subapically changing to numerous narrow spines. All spines point basally.

Fifth thoracopod as in *Branchinella buchananensis* but with epipodite relatively shorter, i.e. length twice width.

Telson and cercopods also as in *Branchinella buchananensis*.

*Female*. Length of adults 16-45.5mm, paralectotype 45.5mm. First antennae (Fig. 8C) filiform and about 1/4 length of second antenna. Second antenna lamellar with a markedly asymmetrical apex with a blunt point and reaching back to 2nd or 3rd thoracic segments. Brood pouch (Fig. 8D) extending back over 2 genital segments and 3.5 abdominal segments; distal part cylindrical. Thoracopods and cercopods similar to those of male.

DIAGNOSIS. Male lacks a frontal appendage, but has an apomedial antennal appendage from basal segment of second antenna. Antennal appendage tubular with short papillae on apical half. Clypeus with a blunt triangular outgrowth ventromedially. Base of penis with a transverse protrusion laterally.

REMARKS. The Queensland material is slightly different from the Victorian specimens in that the antennal appendage is only about 3/4 length of the distal segment of the second antenna and has fewer papillae (Fig. 5D). This difference may not be phenotypic, but could be developmental (cf. remarks on *B. buchananensis*).

## DISCUSSION

*Branchinella clandestina* sp. nov. and *B. mcraei* sp. nov. have characteristics which place them in Geddes (1981) Group 11: both have a frontal appendage consisting of a long trunk and two simple branches, short endopodites, and 2-4 anterior setae on endites 4-6. Geddes (1981)

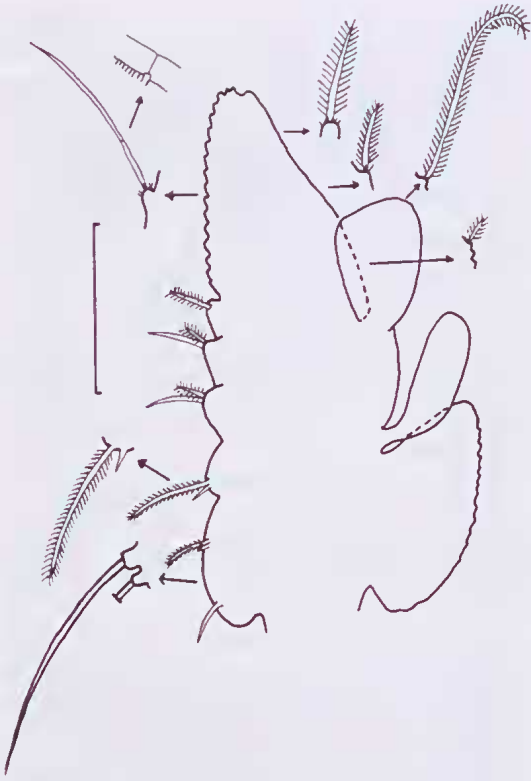


FIG. 7. Fifth thoracopod of *Branchinella buchananensis* Geddes. Scale bar = 1 mm.

places the *B. nicholli* complex (*B. nicholli*, *B. hattahensis*, *B. buchananensis*) among his Group I species, because of their large, robust bodies, long endopodites which are sparsely setulated medially, numerous anterior setae on endites 4-6, and females with long second antennae. While these similarities seem valid morphologically, relationships between species based on mitochondrial DNA did not support these 2 groupings, though it did recognise his Group III (Remigio et al., 2003). Group II species separated on their DNA affinities as 2 groups quite distinct from each other; it is not known to which of the 2 subgroups the new species belong. Group I species also comprise 2 well separated groups, with *B. hattahensis* and *B. buchananensis* comprising 1 subgroup (and presumably *B. nicholli* also belongs here). The other subgroup contains *B. australiensis* and *B. occidentalis*.

The 3 species in the *B. nicholli* group are closely related, probably more so than other species of *Branchinella*. Based on mitochondrial DNA evidence, Remigio et al. (2003) claimed they are of subspecies status, but there are many

distinct morphological differences between the three. In antennal features, *B. buchananensis* is quite different with its antennal appendage having many long papillae on basolateral surface and shorter papillae apically, compared to only a few short papillae mainly in the apical half in *B. nicholli* and *B. hattahensis*. In the later pair there is some variation between populations in these papillae (for *B. nicholli* compare Fig. 5A with 5B; and for *B. hattahensis* compare Figs 5C, 8A with 5D). These 2 species are however easily separated on antennal features, since *B. hattahensis* has a medial process on the clypeus and *B. nicholli* does not. The 3 are also easily separable on features of the male genital area. Both *B. hattahensis* and *B. buchananensis* have a hemispherical cavity between the penis base and lateral outgrowth, whereas *B. nicholli* does not. *B. hattahensis* is unique in having a transverse ridge on the penis base. The penes themselves are similar in structure in *B. buchananensis* and *B. hattahensis*; no data are available for *B. nicholli*. Another difference between the species is in the structure of the fifth thoracopod, with this time *B. nicholli* being the most different. It has 7:7:5 posterior setae on endites 4-6, whereas the other two have 6:5:5 respectively. This slightly greater number of posterior setae is reflected elsewhere on the thoracopod, e.g. ca 50 on the first endite in *B. nicholli* compared to ca 40 in the other 2 species. These differences are about the same order of magnitude as perceived differences among the *B. affinis* group (*B. affinis*, *B. clandestina* sp. nov., *B. latzi*, *B. longirostris*, *B. mcraei* sp. nov. — see earlier in remarks about *B. clandestina* sp. nov.) and also, for example, between *B. halsei* and *B. lyrifera* (Timms & Geddes, 2003). These comparisons indicate that division at the species rank is warranted.

The females of all 3 forms are inseparable from each other, not unusual for *Branchinella* (Geddes, 1981; Timms, 2004). However, *B. buchananensis*, *B. hattahensis* and *B. nicholli* together are distinguishable from other females of *Branchinella* (Timms, 2004). This is because of the lamellar second antennae (Fig. 6B) being about twice the length of the intereye distance, and so much shorter than the lamellar antenna of *B. australiensis* and *B. occidentalis* and much bigger than those of most other species. The brood sac (Fig. 6C) tends to be almost 6 segments long overall and thus is a little longer than in many species of *Branchinella* where it is about 5 segments long.



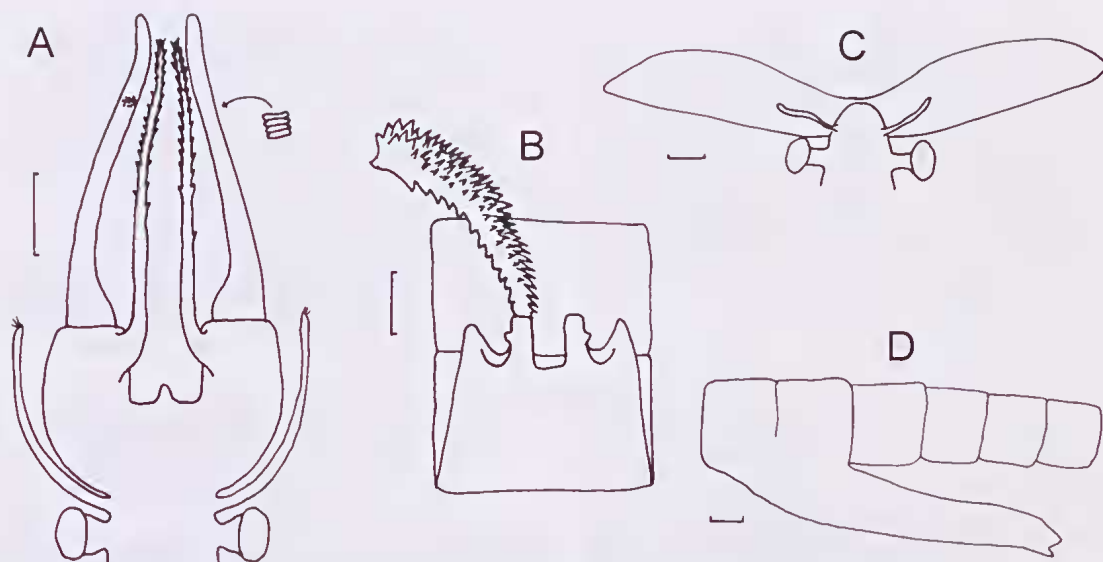


FIG. 8. *Branchinella hattahensis* Geddes. A, dorsal view of ♂ head; B, ventral view of ♂ genital area with one penis everted; C, dorsal view of head of ♀; D, lateral view of brood pouch of ♀. Scale bars = 1mm.

Ecologically, there are similarities but some differences between the 3 species. Geddes (1981) thought, on limited evidence, that all 3 species were halophilic; certainly *B. buchananensis* was reported to live in waters from 15.7–42.6g/L. However Timms (2002) showed that *B. nichollsi* lives in fresh — hyposaline conditions and the highest actual salinity recorded is only 1.5g/L in Lake Arrow (Chapman & Timms, in press). My unpublished records from the Paroo show *B. hattahensis* can live, at most, in subsaline water (i.e. < 3g/L) and *B. buchananensis* lives in hyposaline waters to 15.1g/L. So it seems that *B. buchananensis* is the species with the greatest halotolerance, with the other 2 only slightly more tolerant than most other *Branchinella*, except *B. simplex* and *B. australiensis* (Geddes, 1973). Halotolerance refers to NaCl waters, virtually the only type in Australia (Hart & McKelvie, 1986). Another ecological difference between the 3 species is that *B. nichollsi* and *B. buchananensis* live in lakes that are usually have clear water, whereas *B. hattahensis* lives in turbid freshwater lakes that may increase in salinity as they dry. *B. nichollsi* is apparently confined to a small area in the eastern Goldfields of WA, while *B. hattahensis* occurs from N Victoria to SW Qld, with the northern part of this range overlapping with the distribution of *B. buchananensis* which is now known from NW NSW to NE Qld. The area of overlap is quite small and is restricted to a

small area near Hungerford, SW Qld; in this area, as elsewhere, the 2 species inhabit different types of lakes (Timms & Sanders, 2002).

While the 3 forms in the *B. nichollsi* complex have many morphological similarities, some ecological similarities and are very closely placed in the phylogram of Remigio et al. (2003), I believe they are distinct species, as did Belk & Brtck (1995). Despite some variation between populations, some of which is explainable as variation due to stage of development (as in *B. buchananensis* in Gidgee Lake), each is now known from a number of sites and they are always distinct morphologically. Furthermore, *B. buchananensis* and *B. hattahensis* are sympatric but apparently do not interbreed.

The 5 species discussed here are of very unequal conservation status. *B. buchananensis* has legal status as a vulnerable fish species in NSW (Anon, 2002), but it is unprotected in Queensland. The rationale for this is the limited habitat in NSW is threatened by gypsum mining whereas in Queensland there are no threats to its habitat. The other 4 species are unprotected, and although rarely collected, the habitats of 3 of them are unthreatened. The exception is *B. nichollsi* whose habitat is some episodic salinas in the eastern goldfields of WA (Timms, 2002). The problem is that the hydrology of some of these is being changed by either mining directly on the lake or using the lake as a receiving basin



for saline groundwater. In that the species apparently hatches and grows only in fresh or slightly saline water, the addition of extra salt in its habitat could threaten its existence (see Timms, in press). If IUCN (2000) Red List criteria were applied to the conservation status of these species, all would be classed as 'data deficient' because so little is known on their biology, but more research would probably result in a 'vulnerable' classification for *B. nichollsi* and *B. buchananensis*.

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#### LITERATURE CITED

- ANON 2002. NSW Fisheries – Fishnote NSW 1074. Buchanan's fairy shrimp.
- BELK, D. & BRTEK., J. 1995. Checklist of the Anostraca. *Hydrobiologia* 298: 315-353.
- CHAPMAN A. & TIMMS, B.V. In Press. Waterfowl usage of Lake Arrow, and arid zone wetland in the eastern Goldfields of Western Australia, following cyclonic rain. *Australian Field Ornithology*.
- GEDDES, M.C. 1973. Salinity tolerance and osmotic and ionic regulation in *Branchinella australiensis* and *B. compacta* (Crustacea: Anostraca). *Comparative Biochemistry and Physiology* 45A: 559-169.
1981. Revision of Australian species of *Branchinella* (Crustacea: Anostraca). *Australian Journal of Marine and Freshwater Research* 32: 253-295.
- HART, B.T. & McKELVIE, I.D. 1986. Chemical limnology in Australia. Pp. 3-31. In De Deckker, P. & Williams, W.D. (eds) *Limnology in Australia*. (CSIRO/Junk: Melbourne/Dordrecht).
- INTERNATIONAL UNION OF CONSERVATION OF NATURE AND NATURAL RESOURCES, 2000. IUCN Red List of Threatened Species, compiled by Craig Hilton-Taylor. (IUCN – The World Conservation Union Species Survival Commission: Cambridge).
- LINDER, F. 1941. Contributions to the morphology and the taxonomy of the Branchiopoda Anostraca. *Zoologische Bidrag fran Uppsala* 20: 101-302.
- REMIGIO, E.A., TIMMS, B.V. & HEBERT, P.D.N. 2003. Phylogenetic systematics of the Australian fairy shrimp genus *Branchinella* based on mitochondrial DNA sequences. *Journal of Crustacean Biology* 23: 436-442.
- TIMMS, B.V. 2001. Two new species of fairy shrimp (Crustacea: Anostraca: Thamnocephalidae: *Branchinella*) from the Paroo, Inland Australia. *Records of the Australian Museum* 53: 247-254.
2002. The fairy shrimp genus *Branchinella* (Crustacea: Anostraca: Thamnocephalidae) in Western Australia, including a description of four new species. *Hydrobiologia* 486: 71-89.
2004. An identification guide to the fairy shrimps (Crustacea: Anostraca) of Australia. Cooperative Research Centre for Freshwater Ecology, Identification and Ecology Guide 47.
- In Press. Salt lakes in Australia: present problems and prognosis for the future. *Hydrobiologia*.
- TIMMS, B.V. & GEDDES, M.C. 2003. The fairy shrimp genus *Branchinella* Sayce 1903 (Crustacea: Anostraca: Thamnocephalidae) in South Australia and the Northern Territory, including descriptions of three new species. *Transactions of the Royal Society of South Australia* 127: 53-68.
- TIMMS, B.V. & SANDERS, P.R. 2002. Biogeography and ecology of fairy shrimps (Crustacea: Anostraca) in the middle Paroo catchment of arid-zone Australia. *Hydrobiologia* 486: 71-89.